REMARKS

This amendment is in response to the Office Action dated December 13, 2005. Entry of this Amendment and reconsideration of this application are respectfully requested.

Claim Rejections under 35 USC 112

Claims 2 and 21 were rejected as being indefinite. The Examiner states that the limitation "each of said switch input lines having an associated effective capacitance, said switch input lines designed such that the inductance of each switch input line is matched to its effective capacitance at a given design frequency" is unclear.

This language is clear and unambiguous to those of ordinary skill in the arts of microwave circuit and transmission line design. Requiring that an input line's inductance be matched to its effective capacitance simply means that the susceptance (i.e. the imaginary part of the admittance) from the open-stub transmission line(s) connected to the open switch(es) at each junction be cancelled by an equal reactance from a series inductance matching circuit in front of each junction on the input line - which results in the impedance of an input line becoming largely resistive at the specified design frequency. In this way, the junctions are optimized to provide the best possible impedance match and delay flatness over the operating frequency band. The series inductance compensates for the mismatch that comes from the open-stub transmission line(s) connected to the open switch(es) at each junction. Generally, a reactive element degrades the delay flatness when used alone. However, in this case a proper choice of inductance will reduce

the delay ripple caused by the open stub. Background in the general area of impedance matching is provided in the Wikipedia at http://en.wikipedia.org/wiki/Impedance_matching and at http://en.wikipedia.org/wiki/Maximum_power_theorem#Impedance_matching.

This form of impedance matching maximizes the power transfer via the signal line at a single frequency - hence, the claim's requirement that the inductance and capacitance be matched "at a given design frequency". This objective of the matching requirement is explicitly noted in the specification: see, e.g., page 3, lines 14-18, "This [matching] is done to reduce signal reflections which might arise due to the unterminated open stubs presented to the input signal by open switches; the inductance matching reduces reflections at the design frequency and thus the switch module's insertion loss."

Though the claim language is believed to be clear and precise as originally written, claims 2 and 21 have been amended herein to further clarify the matching limitation, by specifying that "the inductance of each switch input line is matched to its effective capacitance at a given design frequency <u>such that the impedance of each of said input lines is largely resistive at said design frequency</u>." It is believed that this amendment, in combination with the explanation and citations above, overcome the rejection of claims 2 and 21 under 35 USC 112.

<u>Claim Rejections under 35 USC 102</u>

Claims 2, 3, 4 and 6 were rejected under 35 USC 102(e) as being anticipated by a patent application to Vaitkus et al. ("Vaitkus").

There are a number of key parameters of significant importance to the elements of an RF system (such as a switch

matrix or signal routing network of the type described in the present application). These include low insertion loss, low reflection losses, and the maintenance of these characteristics at high signal frequencies. It is true that any switch can be assembled into an SPNT (1:N) configuration, but what distinguishes whether or not that switch network is of practical use is the quality of its RF loss characteristics.

The cited patent application to Vaitkus describes MEMS switches based on electromagnetic actuation mechanisms. The multi-switch circuits described by Vaitkus and shown in his Figs. 6 and 7 have large transmission line segments between the input (604 in Fig. 6, 704 in Fig. 7) and the contact location for the various switches (602, 702). In a configuration where one switch is closed and all the rest are open, there will be a considerable length of unterminated transmission line in the circuit, associated with the signal paths to all the open switches; these unterminated transmission line segments are commonly referred to as "open stub" or "unterminated stub" sections, each of which has an associated capacitance. RF waves traveling down these transmission line segments will encounter a discontinuity at the open switch and be reflected back. These reflections, and their constructive interference (resonances) would seriously degrade the RF performance of the circuit. As such, these switches and their associated multi-switch assembly configurations do not lend themselves to providing low RF losses at high signal frequencies.

A method of minimizing the degradation created by the open stub sections for a 1:N MEM switch network is described and claimed in the present application. As explicitly recited in claim 2, the technique involves matching the inductance of each switch input line with its effective capacitance at a given design frequency; claim 2 has been amended as described above to

state that this matching serves to make the input line impedances largely resistive at the design frequency. The specification refers to several means for realizing this matching (see, e.g., page 6, lines 15-18), including adjusting the width, length, and/or thickness of the switch input line to control the inductive characteristics of the transmission line segment (such as shown segment 18 in FIG. 2), the use of open stubs (such as stub 72 in FIG. 4), and chamfering 90-degree bends (such as corner 52 in FIG. 4).

By matching inductance to effective capacitance in the manner described in claim 2, an input line's reflected energy can be dramatically reduced. Unless these two parameters are properly matched, the performance of the switch network will be seriously degraded.

Vaitkus illustrates three specific configurations for a MEMS-based 1:4 switch network. In all cases, the circuits contain unterminated transmission line segments when one of the switches is closed and the remainder are open. Nowhere in the teaching or claims of Vaitkus is there any consideration of the effective capacitance associated with these unterminated transmission line segments, or of the possibility of matching the inductance of the transmission line segments to the open-stub effective capacitance.

As the patent to Vaitkus neither discloses nor suggests this essential "matching" element of claim 2, it neither anticipates claim 2 nor renders it obvious. Thus, the amended claim 2 should be allowable over the patent application to Vaitkus.

The amended claim 2 is the parent of each of claims 3, 4 and 6, each of which should therefore be allowable with claim 2. However, at least some of these claims should be found to be

allowable on their own merits. For example:

- Claim 3 requires that "at least one of said signal output lines includes one or more open stub sections which effect the matching of said signal output line's inductance to its effective capacitance." The Examiner states that Vaitkus discloses such "open stub" sections, defining them as "the gap between the signal line and the output line for the outputs which are not selected." This is a misinterpretation: as explained in the present application (see, e.g., page 6, lines 10-14; FIG. 2), an open stub section is an unterminated section of an input transmission line associated with an open switch.

The Examiner further states that Vaitkus discloses open stub sections <u>which effect the matching of said signal output line's inductance to its effective capacitance</u>. As noted above, Vaitkus describes no such matching, or any consideration of the inductance or effective capacitance of the transmission lines at all. Lacking any disclosure or suggestion of this element in the cited art, claim 3 should be allowable over Vaitkus on this independent basis.

- Claim 4 requires that "said signal input line has a terminus point and each of said switch input lines is connected to said signal input line at said terminus point, all N of said MEM switches arranged <u>to be rotationally symmetric</u> about said terminus point." Claim 4 has been amended to explicitly require the switches to be rotationally symmetric about the terminus point, as shown in FIGs. 2-5.

This limitation is not disclosed in the cited art. While Vaitkus illustrates mirror symmetry, he does not disclose or suggest rotational symmetry. This is a material difference, since one advantage of the applicants' switch circuit configuration is its compact size, which is enabled by the close packing of

switches effected by the required rotational symmetry. This compactness reduces unterminated line lengths in the unactuated switch lines, and ensures that the switch states all behave the same in terms of their RF properties.

As there is no disclosure or suggestion of this element in the cited art, the amended claim 4 should be allowable over Vaitkus on this independent basis.

Claim Rejections under 35 USC 103

Claims 5 and 13-17 were rejected as obvious in view of Vaitkus et al.

The amended claim 2 is the parent of each of claims 5 and 13-17, each of which should therefore be allowable along with claim 2.

However, the applicants wish to note that at least some of these claims should be found to be allowable on their own merits. For example:

- Claim 5 requires that the rotational symmetry of claim 4 be effected with 4 MEM switches arranged along four sides of a pentagon centered about the terminus point, with the signal input line bisecting the fifth side of the pentagon en route to the terminus point.

As noted above, Vaitkus illustrates mirror symmetry; he does not disclose or suggest rotational symmetry, nor the "four sides of a pentagon" arrangement specified in claim 5. Rather, the configurations disclosed in Vaitkus (see Figs. 6, 7, 8) contain significant unterminated transmission line length. If the problems that this arrangement gives rise to were obvious to someone skilled in the art, a different arrangement would have been selected.

The claimed "four sides of a pentagon" configuration provides a key advantage in minimizing unterminated transmission

line length and enabling the close packing of switches. It also ensures that the switch states all behave the same in terms of their RF properties. Also note that the configuration shown in Vaitkus involves crossovers between the input and output lines, which would not be encountered in the claimed symmetric configuration.

Lacking any disclosure or suggestion of this claim 5 element, the applicants assert that it would not have been obvious in view of the cited art, and thus should be allowable on this independent basis.

Claim 7 was rejected as obvious in view of Vaitkus et al. in view of a patent to Ma.

Claim 7 has been amended to depend from claim 2. As the amended claim 2 is believed to be allowable, the amended claim 7 should also be allowable.

Claims 2, 3, 6, 8-12 and 14-17 were rejected as obvious in view of a patent to Qiu et al. ("Qiu").

As noted above, claim 2 requires matching the inductance of each switch input line with its effective capacitance at a given design frequency, such that the resulting impedances of the input lines are largely resistive at the design frequency. As was true with Vaitkus, nowhere in the teaching or claims of Qiu is there any consideration of the effective capacitance of the unterminated transmission line segments, or of the possibility of matching the inductance and effective capacitance of these transmission line segments.

Furthermore, though Qiu does describe a switch and a combining manifold, there is no discussion of a 1:N switch implementation as recited in claim 2.

The applicants also disagree with the Examiner's contention

that it would have been obvious to just "reverse the direction of the signal in order to route an input signal between various outputs". It is not routine to just reverse direction, because the nature of the RF transmission and reflection properties would change dramatically depending upon what is input and what is output. This is well known to those skilled in the art. For the specific configuration shown by Qiu, note that in addition to the long unterminated line length that would result by reversing the signal direction, the length would change depending upon which switch was closed. This would cause the reflection losses to vary with switch state - a very undesirable problem.

Therefore, Qiu fails to disclose or suggest several of the essential elements of the amended claim 2. As such, the applicants assert that claim 2 would not have been obvious in view of Qiu, and is thus allowable.

The amended claim 2 is the parent of each of claims 3, 6, 8-12 and 14-17, each of which should therefore be allowable along with claim 2. However, some of these claims should be found to be allowable on their own merits. For example:

- Claim 3. The discussion above concerning the merits of claim 3 with respect to Vaitkus is applicable here as well. Claim 3 requires that "at least one of said signal output lines includes one or more open stub sections which effect the matching of said signal output line's inductance to its effective capacitance." The Examiner states that Qiu discloses such "open stub" sections, defining them as "the gap between the signal line and the output line for the outputs which are not selected." But as noted above, this definition is incorrect: an open stub section is an unterminated section of an input transmission line associated with an open switch.

The Examiner further states that Qiu discloses open stub

sections which effect the matching of said signal output line's inductance to its effective capacitance. As noted above, Qui describes no such matching, or any consideration of the inductance or effective capacitance of the transmission lines at all. Lacking any disclosure or suggestion of this element, claim 3 should be allowable over Qiu on this independent basis.

- Claim 9 requires that the drive voltages for at least some of the movable contacts of claim 8 be applied using air bridges which traverse signal lines or traces on the substrate. The Examiner states that this limitation is disclosed in Qiu, and refers to Fig. 8c. This is incorrect. In Fig. 8c, there are no electrical addressing lines on the top surface of the substrate. All addressing lines are associated with the electromagnetic coils, which are exclusively on the bottom surface (as shown in Fig. 8d). Since there are no crossovers of the electrical addressing lines, there is no need for air bridges - and, in fact, no air bridges are shown, taught, suggested, or claimed. Thus, claim 9 should be allowable over Qiu on this independent basis.

- Claim 12 requires each MEM switch to be actuated with a respective drive voltage applied between the movable contact and at least one corresponding trace on the substrate, each of the corresponding traces connected to a via, the vias arranged symmetrically about the terminus point such that at least some of the vias are shared by adjacent switches.

The electromagnetic switch of Qiu does not function in the same way as the electrostatic switch recited in claim 12 (and differs from the thermal or piezoelectric counterparts as well). In Qiu, the actuation is generated by an induced magnetic field generated by passing current through the backside coil. Thus,

there is no drive voltage applied between the movable contact and the front trace as required in claim 12. Further, these traces are not connected to a via (note that in Qiu, #127 in Fig. 8d is a backside connection to an electrical ground serving as a common signal for the multiple coils). Also, Qiu's vias are not symmetrical, and are not shared among adjacent switches - as required by claim 12. Lacking disclosure of all these elements of claim 12, claim 12 should be allowable over Qiu on this independent basis.

All of the claims presently in the application are believed to be patentably distinct with respect to the cited art and to otherwise be in proper form for allowance. A Notice of Allowance is respectfully requested.

Respectfully submitted,

February 28, 2006

Steven C. Patrick
Registration No. 40,341
Attorney for Applicant

KOPPEL, JACOBS, PATRICK & HEYBL
555 St. Charles Drive, Suite 107
Thousand Oaks, California 91360
(805)373-0060